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JSC STS-107 Launch Film Screening Report

STS-I07
Launch Film Screening Report
January 20, 2003
JSC Image Science and Analysis Group Human Exploration Science Office / SX

ANOMALY

E204, E208, E21.2- During ascent at approximately 81 seconds MET, a large light-colored piece of debris was seen to originate from an area near the ET/Orbiter forward attach bipod. The debris appeared to move outboard *in* a -Y direction, tnen fell aft along the left Orbiter fuselage, and struck the underside *(-Z)* of the leading edge of the left wing. The st~ike appears to have occurred on or relatively close to the wing glove near the Orbiter fuselage. After striking the left wing, the debris broke into a spray of white-colored particles that fell aft along the underside (-Z *side)* of the Orbiter left wing. The spray of particles was last seen near the LSRB
exhaust plume.

Comparison views of the strike area immediately before and after the event were examined for indications of damage to the wing. The resolution on the films and videos is insufficient to see individual tiles. However, no indications of damage at a larger scale as indicated by changes in brightness of the wing surface area(s) that may indicate damage was noted.

Still views and enhanced movie loops of this event are available for at the following web address:

<http://sn-isag.jsc.nasa.gov/shuttleweb/mission_support/sts-.107rlaunch_video /lO71aunchvideo.shtml>

The times of this event are as follows:

Debris first seen near ET/Orbiter forward attach Debris contacted left wing:
.016:15:40:21.882 UTC

016:15:40:21.699 UTC

Crew acquired down linked video in:laging the External Tank (ET), probably the source of the debris that struck the Orbiter left wing, was reviewed. Unfortunately the view is of the far side of the ET and provided no information as to the source of the debris object.

A down linked view or the Orbiter left wing upper surface from a payload b~y camera did not image the suspected impact area.

OBSERVATIONS:

Selected lau~ch views are available for viewing at:

<http://sn-isag.jsc.nasa.gov/shuttleweb/mission support/sts-.107/1aunchfilm/ lO71aunchfilm.shtml> --

Other launch film screening event observations similar to those seen on previous missions are:
On the launch video screening report dated 1/16/03 we reported that the right elevon motion may have been greater on STS-107 than has been typically seen. A comparison of the elevon motion was done with views from STS-113 a~d the p~evious Columbia flight (STS-109). It was concluded that the motion on STS-l07 was normal in that it was similar to the elevonmotion seen on STS-113 and STS'-'109.

ES, E17, E18, E19, E20 -Orange vapor (possibly free burning hydrogen) was seen Iorward of the SSME rims and near the base heat shield during SSME ignition. The orange vapor on the STS-l07 films appeared to be similar to
those typically seen on previous mission films and videos.

E19, E20, E76 -During SSME start-up, the SSME Mach diamonds formed in the expected sequence (3, 2, 1). The times for the Mach diamond formation given below are from"the engineering film E76:

SSME *3
SSME *2 SSME #1

-15:38:56.736 UTC -15:38:56.816 UTC -15:38:57.227 UTC

The start times for SSME ignition based on the E76 film were

SSME #3 -15:38:55.215 UTC SSME #2 -15:38:55.355 UTC SSME #1 -15:38:55..455 UTC

E5, E76 -Movement of the SSME #3 Dome Mounted Heat Shield (DMHS) blafiket
was seen during SSME ignition on camera E5. On camera E76, SSME #2 arid SSME #3 DMHS blanket movement was seen during SSME ignition (15:38:56.466 UTC). This event has been seen on previous mission films.

El, E2, E4, ES, E20, E3l -Typical of previous missions, multiple pieces of ice debris were seen falling from the ET!Orbiter umbilicals and along the body flap during SSME ignition through liftoff. Ice debris was seen falling near the LH2 umbilical four inch recirculation line. None of the debris were seen to contact the launch vehic,le.

ES, E18, E20, £31 -A line of frost was visible at the juncture of the base of SSME #2 and the Dome Mounted Heat Shield (DMHS) during li£toff.

E18, E20 -Typical of previous missions, small areas of tile surface material erosion were seen.forming on the base heat shield and oh the RCS stingers at the following times:

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lS:38:56.000UTC -Erosion mark inboard of the left **RCS**

stinger

15:38:56..562UTC -Erosion mark outboard of SSME #2 near the

body flap

15:38:57.329 UTC -Erosion mark on the tip of the left RCS

stinger

15:38:58.639 UTC -Erosion mark on the left OMS pod between the OMS nozzle and vertical stabilizer

E2, E19- Faint, light-orange-colored flashes were seen in the SSME exhaust plumes, possibly debris induced, during SSME ignition and through liftoff at the times shown below:

SSME #1- 15:38:57.728 UTC SSME #1 ..15:38:58.385 UTC SSME #1 -15:38:58.779 UTC SSME #1 -15:38:59.019 UTC SSME #3 -15:38:57.395 UTC SSME #3 -15:38:59.532 UTC

Flashes in the SSME exhaust plume prior to .li£toff have been seen on previous mission films.

E17 -Several small, dark-colored pieces of debris (possibly paint chips) were seen falling from a seam line on the -Z side of the LO2 TSM just before liftoff (15:38:59.566 UTC).

E1, E5, E17, E52 -As typically seen on previous missions, multiple pieces of SRB throat plug and/or SRB flame duct debris were seen near the right and left SRBs during liftoff. On camera E1, two pieces of SRB flame duct debris were seen arcing between the two SRB's and falling aft along the -Z side of the body flap during liftoff (15:39:00.4 UTC). On camera E17, a large appearing, light-colored piece of probable SRB throat plug material was seen aft of the vehicle during liftoff (15:39:01.873 UTC). At liftoff, light-colored debris was seen falling aft near the +Y side of the RSRB aft skirt (15:39:02.456 UTC). On camera E52, debris from the base of the SRB's was seen traveling north of the MLP at liftoff (15:39:02.203 UTC).

E5- A light-colored piece of debris was seen falling aft .from near the EVRSRB aft attach during liftoff (15:39:01.235 UTC).

EB -SRB ignition was at 15:39:00.000 OTC based on the observation of the PIC firing at RSRB holddown post M-2.

E18 -A dark,-colored, flexible, strap or tag-like object was seen on the LH2 TSM T-O umbilcal disconnect prior to liftoff.

E19 -A long, dark-colored, flexible, strap-like obj~ct was seen coming .from the top of the LH2 TSM T-Q door before detaching and falling aft in front of the TSM T-Q door after liftoff (15:39:03.582 UTC)

E8, E13 -The left and right SRB GN2 purge lines appeared wrapped, upright, and intact until they were obscured by exhaust plumes at 15:39:00.000 UTC (right purge line) and 15:39:00.003 UTC (left purge line).

E7, E1O, Ell, E14 -The left and J;:ight SRB north holddown post bl.ast shields closed prior to when the SRB nozzle exit plane rose past the level of the SRB holddown post shoes, as they are designed to do. However, the holddown post M4 blast shield may have closed quicker than typical.

E33, E34, E36, E39, E52- The GH2 vent arm retraction appeared normal. Ice and vapo+:s were seen falling aft along the ET during the vent arm retraction. The GH2 vent arm contact with the deceleration cable on the E39 camera close-up view from inside'the FS$ of the vent arm capture was visible.. As designed, the arm appeared to make contact very close to the center position of the deceleration cable. The vent arm appeared to latch

normally with tlorebourid. A measurement of the position of the vent arm with respect to the center of the deceleration cable at the time of initial contact will be made and reported separately.

E207, E2l2 -An assessment or the body flap motion d1,lring ascent compared to that seen on previous missions could not be made beca1,lse of the soft focus on the STS':'107 long range tracking camera views.

E52, E2l2, E2l3, E222, E223- Multiple pieces of debris, too numerous to count (mostly umbilical ice and RCS paper debris), were seen falling aft of the launch vehicLe during ascent. Umbilical ice and RCS paper debris during ascent has been seen on previous mission films and videos. Examples are:

15:39:17.021 UTC: Forward RCS paper debris noted falling aft along the right wing (E52)
15:39:20.093 UTC:
15:39:20.169 UTC:
15:39:23.9 UTC:
body flap. (E213)
Frame 960: RCS paper debris noted fa.Uing a£t of SSME exhaust plume

RCS paper debris noted. (E223)
Spray of RCS paper debris noted aft of the SSMEs. (E222) Debris from ET!Orbiter urilbilicals noted falling aft along

(E212)

E5, E20, E31, E52, E212, E222 -Pieces of orange-colored umbilical purge barrier material were seen falling aft along the -Z side of the body flap during SSME ignition .(15:38:57.703 UTC). On camera E20, three pieces of light-orange colored umbilical purge barrier material were noted falling aft near SSME *2 prior to liftoff (15:38:58.394 UTC). Umbilical purge barrier material was seen falling along the body flap during tower clear on camera E52. On camera E222, a piece of umbilical purge barrier material was seen near the Orbiter right wing during liftoff .(15:39:03.014 UTC). During early ascent, multiple pieces of umbilical purge barrier material were seen falling aft of the left wing on the camera E52 view. On camera E212, a piece of umbilical purge barrier mat.erial was seen falling along the body flap. On camera E222,a piece of umbilical purge barrier material was seen falling aft of the body flap at approximately 32 seconds MET {15:39:31.840 UTC}.Purge barrier material falling from the ET umbilicals has been typically seen on previous mission tracking camera views.

Cameras E52, E213, E220, E222, E223 -Light-colored flares (possibly debris induced) were seen in the SSME exhaust plumes during ascent on the intermediate and long range tracking camera films. Examples of the flares observed are:

15:39:14.576 UTC: 15:39:33.178 UTC: 15:39:33.424 UTC: 15:39:33.471 UTC: 15:39:33.475 UTC: 15:39:35.469 UTC: 15:39:35.633 UTC: 15:39:37.175 UTC: 15:39:37.177 UTC: 15:39:40.367 UTC: 15:39:33.168 UTC: 15:39:41.992 UTC: 15:39:51.001 UTC: 15:39:57.060 UTC:

Flare noted in SSME exhaust plume (E52) Flare seen in SSME exhaust plume (E213) Flare seen in SSME exhaust plume (E2l3) Flare seen in SSME exhaust plume (E222) Flare seen iD SSME exhaust plume (E213) Flare seen in SSME exhaust plume (E2l3) Flare seen iD SSME exhaust plume (E213)
Flare seen in SSME exhaust plume (E222) Flare seen in SSME exhaust plume (E213) Flare seen iD SSME exhaust plume (E213) Flare seen in SSME exhaust plume (E2l3) Flare seen in SSME exhaust plume (E213) Flare seen in SSME exhaust plume (E220) Flare seen in SSME e~haust plume (E223)

Flares in the SSME exhaust plumes have been seen on previous missions films and videos.'

E204, E207, E220, E222, E223 -As on previous missions, debris was seen exiting the SRB exhaust plumes. The debris exiting the SRB exhaust plumes during the majority of ascent is probably instafoam from the aft end of the SRBs. The more dense appearing debris near the time of. tail-off, just prior to SRB separation, is probablySRB slag debris. Examples of this debris are:

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15:39:27.186 UTC 15:39:48.926 UTC 15:39:49.350 UTC

Debris seen falling along SE,B exhaust plume (E223) Debris seen falling along SRB exhaust plume (E220) Debris seen falling along SRB exhaust plume (E223)

SRB separation was timed at 15:41:,O6..536UTC on camera E207

Other normal events observed included: RCS paper debris, ice and vapor from t.he LO2 and LH2 TSM T-O umbilicals prior to and after disconnect, ET twang, multiple pieces of debris in the exhaust cloud after liftoff including rope-like debris (probable water baffle material), acoustic waves in the exhaust cloud after li£toff, charring of the ET aft dome, ET aft dome outgassing, vapor off the SRB stiffener rings, expansion waves, linear optical effects, recirculation, SRB plume brightening, and SRB slag debris after SRB separation.

Normal Pad events observed included: Hydrogen igniter operat;ion, MLP deluge water activation, FSS deluge water op,eration, LH2 and LO2 TSM door closure, and so\,1nd suppression system water operation.

NOTES:

Twelve 16 rom films, thirteen 35 rom films, and 24 launch videos were screened. The focus on several of the long range tracking camera film views was very soft which hindered imagery analysis and the analysis of the debris strike to the Orbiter wing.

This concludes the routine JSC STS-1O7 launch film and video screening. Image enhancements of the debris strike event, web site updates, or other special support requests, will be performed prior to landing.

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